M

MANY

PRIN

ROBINSON'S MATHEMATICAL SERIES.

THE

METRIC SYSTEM

OF

WEIGHTS AND MEASURES;

COMBINING

MANY NEW AND PRACTICAL IMPROVEMENTS IN ARRANGEMENT, NOTATION, AND APPLICATIONS.

PREPARED FOR

ROBINSON'S PROGRESSIVE ARITHMETICS,

By MALCOM McVICAR, A. M
PRINCIPAL OF THE STATE NORMAL AND TRAINING SCHOOL AT BROCKPORT, N.Y.

LIBRARY OF CONGRESS
1868
COPYRIGHT OF WASHINGTON

NEW YORK:
IVISON, PHINNEY, BLAKEMAN & CO.
PHILADELPHIA: J. B. LIPPINCOTT & CO.
CHICAGO: S. C. GRIGGS & CO.

PREFACE.

In the discussion of the Metric System of Weights and Measures presented in these pages, the following points claim special attention: —

1st. The clear and comprehensive manner in which the nomenclature is presented in the general analysis on pages 8 and 9.

2d. The simple and entirely *original* abbreviation of the nomenclature, completely retaining its expressiveness and universality, and at the same time adapting it to the wants of business men. This abbreviation obviates one of the greatest objections to the use of the Metric System.

3d. Its simple, original, and scientific notation.

4th. Its full and intelligible exhibit of the measurement of surfaces, solids, and angles.

5th. The employment of but two simple rules for changing from the old system to the new, and from the new system to the old.

Entered, according to Act of Congress, in the year 1867, by
DANIEL W. FISH, A.M.,
In the Clerk's Office of the District Court of the United States for the Eastern District of New York.

of Weights and
ollowing points

anner in which
eral analysis on

abbreviation of
s expressiveness
apting it to the
on obviates one
Metric System.
notation.
f the measure-

mple rules for
w, and from the

967, by

tern District of New York.

THE METRIC SYSTEM

OF

WEIGHTS AND MEASURES.

INTRODUCTION.

The metric system of weights and measures — so called, because the metre is the unit from which the other units of the system are derived — had its origin in France during the Revolution, a time when all regard for institutions of the past was repudiated. In the year 1790, the French government resolved to introduce a new system; and, in order that it might be received with general favor, other countries were invited to join with it in the choice of new units. In response to this invitation, a large number of scientific men, commissioned by various countries, met in Paris, in consultation with the principal men of France. In the year 1791, a commission, nominated by the Academy of Sciences, was appointed by the Government to prepare the new system. The first work of the commission was to select a standard of lengths from which the system of units adopted might at any time be restored if from any cause the original unit should be lost. A quadrant of the earth's meridian was chosen as the standard, and the ten-millionth part of it taken as the unit of lengths, which was called a metre. In 1795, this standard and a provisional metre whose length was determined from measurements

of the earth's meridian, which had already been made, was adopted by the government.

In the meantime, two eminent astronomers, Mechain and Delambre, were engaged in determining the exact length of the arc of the meridian between Dunkirk in the north of France, and Barcelona in Spain. At a later period, Biot and Arago measured the prolongation of the same meridian as far as the island of Formentara. From these measurements, together with one formerly made in Peru, they deduced, as they supposed, the exact distance from the equator to the pole, which differed slightly from the standard assumed in 1795. In 1799, a law was passed changing the length of the metre adopted in 1795 so as to conform with this difference. The metre thus determined was marked by two very fine parallel lines drawn on a platinum bar, and deposited for preservation in the national archives.

While a part of the commission were engaged in establishing the exact length of the metre, other members pursued a course of investigation for the purpose of determining a unit of weights, which would sustain an invariable relation to the unit of lengths. As the result of their investigations, the weight of a cube of pure water whose edge was one-hundredth part of a metre was the unit chosen. The water was weighed in a vacuum, at a temperature of 4° C., or 39.2° F., which was supposed to be the temperature of greatest density. This weight was called a *gramme;* and a piece of platinum weighing one thousand grammes was deposited as the standard of weights in the national archives.

Had the work of the commission ended in determining these standards of lengths and weights, their labor would have been futile. For, while the conception of basing their system upon an absolute standard in nature was good, the execution proved a failure. Later investigations have shown that the metre is less than the ten-millionth part of the earth's meridian; consequently the metric system of weights and measures is referable not to an invariable standard in nature, but to the platinum metre deposited in the national archives of France. The great benefits which result from the labors of the commission arise from the adoption of the decimal scale of units, and a simple yet general and expressive nomenclature. The amount of

en made, was adopted

Iechain and Delambre, of the arc of the meri- ice, and Barcelona in easured the prolonga- of Formentara. From ly made in Peru, they e from the equator to lard assumed in 1795. h of the metre adopted

The metre thus de- l lines drawn on a pla- e national archives. ged in establishing the sued a course of inves- of weights, which would ngths. As the result pure water whose edge it chosen. The water of 4° C., or 39.2° F., greatest density. This platinum weighing one ndard of weights in the

in determining these would have been futile. stem upon an absolute roved a failure. Later s than the ten-millionth the metric system of invariable standard in n the national archives from the labors of the imal scale of units, and ature. The amount of

time and money used in carrying on exchanges between different countries, which would be saved by the universal adoption of this system, is incalculable. The system was declared obligatory throughout the whole of France after Nov. 2, 1801; but, owing to the prejudices of the people in favor of established customs, and the confusion consequent upon the use of the new measures, the Government, in 1812, adopted a compromise, in the *système usuile*, whose principal units were the new ones, while the divisions and names were nearly those formerly in use, ascending commonly in the ratios of two, three, four, eight, or twelve. In 1837, the government abolished this system, and enacted a law attaching a penalty to the use of any other than the metric system after Jan. 1, 1841. Since that time, the system has been adopted by Spain, Belgium, and Portugal, to the exclusion of other weights and measures. In Holland, other weights are used only in compounding medicines. In 1864, the system was legalized in Great Britain; and its use, either as a whole or in some of its parts, has been authorized in Greece, Italy, Norway, Sweden, Mexico, Guatemala, Venezuela, Ecuador, United States of Columbia, Brazil, Chili, San Salvador, and Argentine Republic. In 1866, Congress authorized the metric system in the United States by passing the following bills and resolution: —

An Act to authorize the use of the Metric System of Weights and Measures.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That, from and after the passage of this Act, it shall be lawful throughout the United States of America to employ the Weights and Measures of the Metric System: and no contract or dealing, or pleading in any court, shall be deemed invalid, or liable to objection, because the weights or measures expressed or referred to therein are weights or measures of the Metric System.

Section 2. *And be it further enacted,* That the tables in the schedule hereto annexed shall be recognized in the construction of contracts, and in all legal proceedings, as establishing, in terms of the weights and measures now in use in the United States, the equivalents of the weights and measures expressed therein in terms of the Metric System; and said tables may be lawfully used for computing, determining, and expressing in customary weights and measures, the weights and measures of the Metric System.

A Bill to authorize the Use in Post Offices of the Weights of the Denomination of Grammes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Postmaster General be, and he is hereby, authorized and directed to furnish to the post-offices exchanging mails with foreign countries, and to such other offices as he shall think expedient, postal balances denominated in grammes of the metric system; and, until otherwise provided by law, one-half ounce avoirdupois shall be deemed and taken for postal purposes as the equivalent of fifteen grammes of the metric weights, and so adopted in progression; and the rates of postage shall be applied accordingly.

Joint Resolution to enable the Secretary of the Treasury to furnish to each State one set of the Standard Weights and Measures of the Metric System.

Be it resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of the Treasury be, and he is hereby, authorized and directed to furnish to each State, to be delivered to the governor thereof, one set of the standard weights and measures of the metric system, for the use of the States respectively.

TABLES AUTHORIZED BY CONGRESS.

MEASURES OF LENGTHS.

Metric Denominations and Values.		Equivalents in Denominations in use.
Myriametre,...	10,000 metres,.....	6.2137 miles.
Kilometre, ...	1,000 metres,.....	0.62137 miles, or 3280 feet, 10 inches.
Hectometre,...	100 metres,.....	328 feet and 1 inch.
Decametre, ...	10 metres,.....	393.7 inches,
Metre,.....	1 metre, ...	39.37 inches.
Decimetre,....	$\frac{1}{10}$ of a metre, ..	3.937 inches.
Centimetre, ...	$\frac{1}{100}$ of a metre, ..	0.3937 inch.
Millimetre,...	$\frac{1}{1000}$ of a metre, ..	0.0394 inch.

MEASURES OF SURFACES.

Metric Denominations and Values.		Equivalents in Denominations in use.
Hectare,.....	10,000 square metres,	2.471 acres.
Are, ...	100 square metres,	119.6 square yards.
Centiare, ...	1 square metre,	1550 square inches.

MEASURES OF CAPACITY.

Metric Denominations and Values.			Equivalents in Denominations in use.	
Names.	No. of litres.	Cubic Measure.	Dry Measure.	Liquid or wine measure.
Kilolitre, or stere,	1000	1 cubic metre, ...	1.308 cubic yd.	264.17 gallon.
Hectolitre, ...	100	$\frac{1}{10}$ of a cubic metre, ...	2 bu. 3.35 pk...	26.417 gallon.
Decalitre, ...	10	10 cubic decimetres,...	9.08 quarts,....	2.6417 gallon.
Litre, ...	1	1 cubic decimetre,.....	0.908 quart, ...	1.0567 quart.
Decilitre, ...	$\frac{1}{10}$	$\frac{1}{10}$ of a cubic decimetre,	6.1022 cubic in.	0.845 gill.
Centilitre, ...	$\frac{1}{100}$	10 cubic centimetres, ..	0.6102 cubic in.	0.338 fluid oz.
Millilitre, ...	$\frac{1}{1000}$	1 cubic centimetre, ...	0.061 cubic in. .	0.27 fluid dr.

WEIGHTS.

Metric Denominations and Values.			Equivalents in Denominations in use.
Names.	Number of grammes.	Weight of what quantity of water at maximum density.	Avoirdupois weight.
Millier, or tonneau,.	1,000,000	1 cubic metre,.....	2204.6 pounds.
Quintal,.....	100,000	1 hectolitre, ...	220.46 pounds.
Myriagramme,.....	10,000	10 litres, ...	22.046 pounds.
Kilogramme, or kilo,	1,000	1 litre, ...	2.2046 pounds.
Hectogramme,.....	100	1 decilitre, ...	3.5274 ounces.
Decagramme,.....	10	10 cubic centimetres,.....	0.3527 ounce.
Gramme,.....	1	1 cubic centimetre, ...	15.432 grains.
Decigramme,.....	$\frac{1}{10}$	1-10 of a cubic centimetre,	0.5432 grain.
Centigramme, ...	$\frac{1}{100}$	10 cubic millimetres,.....	0.1543 grain.
Milligramme.....	$\frac{1}{1000}$	1 cubic millimetre,.....	0.0154 grain.

NOTE. — The spelling in the above tables is not the same as in the tables in the schedule annexed to the report of the committee of the House of Representatives on weights and measures. The change is not made to indicate any preference for any standard upon this subject; but to carry out what the author believes to be an essential condition to the utility and success of the system.

As remarked by a distinguished senator when the tables were adopted by Congress, "*The names are cosmopolitan;*" *and to retain this character fully, the spelling must also be cosmopolitan.*

The French introduced the nomenclature and spelling; and, so long as the names remain unchanged, the spelling should be retained.

NOMENCLATURE AND TABLES.

There are eight kinds of quantities for which tables are usually constructed; viz., Lengths, Surfaces, Volumes or Solids, Capacities, Weights, Values, Times, and Angles or Arcs. The table for Times is the same in the metric as in the ordinary system. The table for Angles is constructed upon a centesimal scale. The tables for the other six kinds of quantities are constructed upon a decimal scale. In each of the tables for Lengths, Surfaces, Volumes, Capacities, and Weights, there are eight denominations of units, — one principal and seven derivative. The principal units are the *metre*, which is the base of the system, and those derived directly from it. The two following tabular views present the facts regarding the principal and derivative units, which should be fixed in the memory.

PRINCIPAL UNITS.

I. METRE, ..
1. Principal unit of Lengths.
2. The base of the metric system, and nearly one ten-millionth part of a quadrant of the earth's meridian.
3. Equivalent, 39.3708 inches.

II. ARE, ...
1. Principal unit of surfaces.
2. A square whose side is ten metres.
3. Equivalent, 119.6 square yards.

III. STERE, ..
1. Principal unit of volumes or solids.
2. A cube whose edge is one metre.
3. Equivalent, 1.308 cubic yards.

IV. LITRE, ..
1. Principal unit of capacities.
2. A vessel whose volume is equal to a cube whose edge is one-tenth of a metre.
3. Equivalent, .908 quart dry measure, or 1.0567 quarts wine measure.

V. GRAMME,
1. Principal unit of weights.
2. The weight of a cube of pure water whose edge is 1.100 of a metre.
3. The water must be weighed in a vacuum 4° C., or 39.2° F.
4. Equivalent, 15.432 grains.

DERIVATIVE UNITS.

I. How Derived.

1. Three orders of smaller units, or submultiples of each kind, are formed by dividing each of the principal units into tenths, hundredths, and thousandths.
2. Four orders of larger units, or multiples of each kind, are formed by considering as a unit ten times, one hundred times, one thousand times, and ten thousand times, each of the principal units.

II. Names how Formed.

1. General Principle.

The names of derivative units are formed by attaching a prefix to the name of the principal unit from which they are derived, which indicates their relation to the principal unit.

2. For Submultiples, Latin Ordinals are used as Prefixes.

1. Millesimus, one thousandth, contracted Milli. *Example*, Millilitre = $\frac{1}{1000}$ of a litre; 8 millilitres = $\frac{8}{1000}$ of a litre.
2. Centesimus, one hundredth, contracted centi. *Ex.*, Centiare = $\frac{1}{100}$ of an are; 4 centiares = $\frac{4}{100}$ of an are.
3. Decimus, tenth, contracted deci. *Ex.*, Decimetre = $\frac{1}{10}$ metre; 3 decimetres = $\frac{3}{10}$ metre.

3. For Multiples, Greek Cardinals are used as Prefixes.

1. Deca, ten. *Example*, Decametre = 10 metres; 5 decametres = 50 metres.
2. Hecaton, one hundred, contracted hecto. *Ex.*, Hectolitre = 100 litres; 7 hectolitres = 700 litres.
3. Kilioi, one thousand, contracted kilo. *Ex.* Kilogramme = 1000 grammes.
4. Myria, ten thousand. *Ex.*, Myriastere = 10,000 steres; 3 myriasteres = 30,000 steres.
5. The *a* in deca and myra, and the *o* in hecto and kilo, are dropped when prefixed to *are*.

III. Order of Progression in Tables.

The tables being constructed upon a decimal scale, ten units of a lower order make one of the next higher, thus: 10 millimetres = 1 centimetre; 10 centimetres = 1 decimetre; 10 decimetres = 1 metre; 10 metres = 1 decametre, &c.

The facts in the preceding views being mastered, the tables can be constructed by the pupil at sight. For example: The names of the derivative units are formed by attaching the seven prefixes, in their order, to the principal units of the tables. The order of progression being ten, the table of capacities will be written thus: —

10 Millilitres	= 1 Centilitre.	10 Litres	= 1 Decalitre.
10 Centilitres	= 1 Decilitre.	10 Decalitres	= 1 Hectolitre.
10 Decilitres	= 1 Litre.	10 Hectolitres	= 1 Kilolitre.
		10 Kilolitres	= 1 Myrialitre.

All the tables peculiar to the Metric System are presented together in a convenient form in the two following tables: —

TABLE OF SUBMULTIPLES AND PRINCIPAL UNITS.

Names of Units.		Pronunciation.	Symbols.
Prefix.	Base.		
10 Milli- Equal 1 Centi-	Metre	Mill′-e-mee′-ter	$_3$M
	Are	Mill′-e-âre	$_3$A
	Stere	Mill′-e-stêr	$_3$S
	Litre	Mill′-e-li′-ter	$_3$L
	Gramme	Mill′-e-gram	$_3$G
10 Centi- Equal 1 Deci-	Metre	Sent′-e-mee′-ter	$_2$M
	Are	Sent′-e-âre	$_2$A
	Stere	Sent′-e-stêr	$_2$S
	Litre	Sent′-e-li′-ter	$_2$L
	Gramme	Sent′-e-gram	$_2$G
10 Deci- Equal 1 Principal Unit.	Metre	Des′-e-mee′-ter	$_1$M
	Are	Des′-e-âre	$_1$A
	Stere	Des′-e-stêr	$_1$S
	Litre	Des′-e-li′-ter	$_1$L
	Gramme	Des′-e-gram	$_1$G
10 Principal Units Equal 1 Deca-	Metre	Mee′ter	M
	Áre	Are	A
	Stere	Stêr	S
	Litre	Li′-ter	L
	Gramme	Gram	G

nastered, the tables can be
ample: The names of the
ne seven prefixes, in their
The order of progression
ritten thus: —

res	=	1 Decalitre.
ecalitres	=	1 Hectolitre.
ectolitres	=	1 Kilolitre.
rialitre.		

stem are presented together
ables: —

PRINCIPAL UNITS.

UNCIATION.	SYMBOLS.
e-mee′-ter	$_3$M
e-âre	$_3$A
e-stêr	$_3$S
e-li′-ter	$_3$L
e-gram	$_3$G
-e-mee′-ter	$_2$M
-e-âre	$_2$A
-e-stêr	$_2$S
-e-li′-ter	$_2$L
-e-gram	$_2$G
e-mee′-ter	$_1$M
e-âre	$_1$A
e-stêr	$_1$S
e-li′-ter	$_1$L
e-gram	$_1$G
er	M
	A
	S
r	L
	G

TABLE OF MULTIPLES.

NAMES OF UNITS.		PRONUNCIATION.	
PREFIX.	BASE.		
10 Deca- Equal 1 Hecto-	Metre	Dek′-a-mee-ter	^{1}M
	Are	Dek′-âre	^{1}A
	Stere	Dek′-a-stêr	^{1}S
	Litre	Dek′-a-li′-ter	^{1}L
	Gramme	Dek′-a-gram	^{1}G
10 Hecto- Equal 1 Kilo-	Metre	Hec′-to-mee-ter	^{2}M
	Are	Hec′-târe	^{2}A
	Stere	Hec′-to-stêr	^{2}S
	Litre	Hec′-to-li′-ter	^{2}L
	Gramme	Hec′-to-gram	^{2}G
10 Kilo- Equal 1 Myria-	Metre	Kill′-o-mee-ter	^{3}M
	Are	Kill′-âre	^{3}A
	Stere	Kill′-o-stêr	^{3}S
	Litre	Kill′-o-li′-ter	^{3}L
	Gramme	Kill′-o-gram	^{3}G
Myria-	Metre	Mir′-e-a-mee-ter	^{4}M
	Are	Mir′-e-âre	^{4}A
	Stere	Mir′-e-a-stêr	^{4}S
	Litre	Mir′-e-a-li′-ter	^{4}L
	Gramme	Mir′-e-a-gram	^{4}G

ABBREVIATED NOMENCLATURE.

To secure the fullest advantage to business men by the universal adoption of the new system of weights and measures, it is necessary that the names used should be short and easy to write and pronounce, that they should express clearly the relation of the different denominations of the same table to each other, and that they should be identical in all languages.

The last two of these requirements would be secured by the universal use of the nomenclature adopted by the French. It is cosmopolitan in its character: it belongs to their language no more than to any other. The former, however, is not secured. It is evident to all, that, for business purposes, the long names of the metric system are inconvenient, and that to shorten them would prove a great

advantage. Efforts have been made to introduce short names; but these efforts have invariably sacrificed their universal and expressive character, which is of more importance to the business world than their shortness.

The only true course which seems to be open, is to abbreviate the names already introduced, in such a way as to retain their peculiar characteristics.

To secure this, the following plan of abbreviation is suggested: —

First. Let the prefixes be abbreviated thus: Myr, kil, hect, dec, des, cent, mil.

Second. Let the initial letter of the names of the five principal units be used, instead of the names themselves, thus: For metre, use a capital M; for are, use a capital A; for stere, a capital S; for litre, a capital L; and, for gramme, a capital G.

Third. For the names of multiples and sub-multiples, attach to these initial capital letters the abbreviated prefixes, thus: Kil M, pronounced kill-em′; Kil S, pronounced kill-ess′, &c.

By this method of abbreviation, the elements of the original terms are retained in such a form that each part is clearly indicated. The capital letter used after the prefix will always point to the base-word of which it is the initial, although the pronunciation is changed.

TABLES WITH ABBREVIATED NOMENCLATURE.

MEASURES OF LENGTHS.

Written.	Pronounced.		
10 Mil M,	Mill-em′,	make	1 Cent M.
10 Cent M,	Cent-em′,	"	1 Des M.
10 Des M,	Des-em′	"	1 M.
10 M,	Em	"	1 Dec M.
10 Dec M,	Dek-em′,	"	1 Hect M.
10 Hect M,	Hect-em′,	"	1 Kil M.
10 Kil M,	Kill-em′,	"	1 Myr M.
Myr M,	Mir-em′.		

roduce short names;
universal and expres-
to the business world

n, is to abbreviate the
o retain their peculiar

iation is suggested: —
s: Myr, kil, hect, dec.

es of the five principal
, thus: For metre, use
stere, a capital S; for
G.
sub-multiples, attach to
ixes, thus: Kil M, pro-
, &c.
ts of the original terms
clearly indicated. The
point to the base-word
ciation is changed.

OMENCLATURE.

IS.

e	1 Cent M.
	1 Des M.
	1 M.
	1 Dec M.
	1 Hect M.
	1 Kil M.
	1 Myr M.

MEASURES OF SURFACES.

Written.	Pronounced.		
10 Mil A,	Mill-ā′,	make	1 Cent A.
10 Cent A,	Cent-ā′,	"	1 Des A.
10 Des A,	Des-ā′,	"	1 A.
10 A,	Ā,	"	1 Dec A.
10 Dec A,	Dek-ā′,	"	1 Hect A.
10 Hect A,	Hect-ā′,	"	1 Kil A.
10 Kil A,	Kill-ā′,	"	1 Myr A.
Myr A,	Mir-ā′.		

MEASURES OF VOLUMES, OR SOLIDS.

Written.	Pronounced.		
10 Mil S,	Mill-ess′,	make	1 Cent S.
10 Cent S,	Cent-ess′,	"	1 Des S.
10 Des S,	Des-ess′,	"	1 S.
10 S,	Ess,	"	1 Dec S.
10 Dec S,	Dek-ess′,	"	1 Hect S.
10 Hect S,	Hect-ess′,	"	1 Kil S.
10 Kil S,	Kill-ess′,	"	1 Myr S.
Myr S,	Mir-ess′.		

MEASURES OF CAPACITY.

Written.	Pronounced.		
10 Mil L,	Mill-ell′,	make	1 Cent L.
10 Cent L,	Cent-ell′,	"	1 Des L.
10 Des L,	Dess-ell′	"	1 L.
10 L,	Ell,	"	1 Dec L.
10 Dec L,	Dek-ell′,	"	1 Hect L.
10 Hect L,	Hect-ell′,	"	1 Kil L.
10 Kil L,	Kill-ell′,	"	1 Myr L.
Myr L,	Mir-ell′.		

MEASURES OF WEIGHTS.

Written.	Pronounced.		
10 Mil G,	Mill-gee′,	make	1 Cent G.
10 Cent G,	Cent-gee′,	"	1 Des G.
10 Des G,	Des-gee′,	"	1 G.
10 G,	Gee,	"	1 Dec G.
10 Dec G,	Dek-gee′,	"	1 Hect G.
10 Hect G,	Hect-gee′,	"	1 Kil G.
10 Kil G,	Kill-gee′,	"	1 Myr G.
Myr G,	Mir-gee′.		

NOTATION AND NUMERATION.

In the practical application of the metric system, it is not always convenient to use the principal units as the unit of number. For example: Should the gramme, the principal unit of weight, be used as the unit of number, in the grocery or any similar business, small quantities would be expressed by inconveniently large numbers. Example: 386 lbs. are expressed by 175,000 grammes. To avoid this inconvenience, the higher denominations are used as the unit of number when large quantities are measured.

No general system of notation is yet agreed upon. The same quantity is written in various ways by different authors. Example: 42 metres, 8 decimetres, and 5 centimetres, are written

42.85 M. 42^{m} 85. $\overset{m\ cm}{42.85}$. M 42.85. &c.

Inasmuch as the principal units of measure are not always used as the unit of number, it is important that a system of notation be adopted, which will apply equally well to both principal and derivative units.

It is believed that the system given below, while simple and convenient, expresses clearly the relation of the unit of number to the principal unit of measure; and, hence, has an advantage over any contractions of the names of the derivative units or arbitrary signs which might be adopted.

1 Cent G.
1 Des G.
1 G.
1 Dec G.
1 Hect G.
1 Kil G.
1 Myr G.

TION.

stem, it is not always
unit of number. For
nit of weight, be used
similar business, small
iently large numbers.
) grammes. To avoid
re used as the unit of

eed upon. The same
t authors. Example :
re written

M 42.85. &c.

are not always used as
em of notation be adopt-
rincipal and derivative

, while simple and con-
unit of number to the
an advantage over any
units or arbitrary signs

GENERAL PRINCIPLES OF NOTATION.

I. The scale in the metric system being decimal, the consecutive denominations are expressed by the consecutive orders of units in a number. Thus, 78642.358 metres is an expression for 7 myriametres, 8 kilometres, 6 hectometres, 4 decametres, 2 metres, 3 decimetres, 5 centimetres, 8 millimetres.

II. Whichever one of the eight denominations of units of measure is used as the unit of a number, the higher denominations are expressed as tens, hundreds, and so on ; and the lower as tenths, hundredths, and so on. Example : 784.56 decametres. Here the unit of the number is a decimetre ; consequently the tens and hundreds are, respectively, hectometres and kilometres, and the tenths and hundredths are metres and decimetres.

From these principles and illustrations, we derive the following rule for notation : —

Rule. *Write the consecutive denominations in their order, commencing with the higher, and placing a cipher wherever a denomination is omitted, and the decimal point after the denomination which is the unit of the number.*

RULES FOR INDICATING THE DENOMINATION.

Rule I. *When a principal unit of measure is the unit of number, place the initial letter of the unit used before the number, thus :* M 342.5. *Read, three hundred and forty-two and five-tenths metres ; or,* 3 *hectometres,* 4 *decametres,* 2 *metres,* 5 *decimetres.*

EXAMPLES FOR PRACTICE.

Write the numbers which represent the following quantities, considering the principal unit of measure the unit of number.

1. Seven myriametres, 4 hectometres, three decametres, and eight centimetres. *Ans.* M 70430.08.
2. Thirty-four kilometres and forty-three millimetres. *Ans.* M 34000.043.
3. Eighty-seven hectogrammes and fifty-nine centigrammes. *Ans.* G 8700.59.

4. Thirty-two myriagrammes, forty-eight decagrammes, five milligrammes. *Ans.* G 320480.005.

5. Three hundred and two kilares, eight hundred and seven centiares. *Ans.* G 302008.07.

6. Four myrialitres, sixty-two decalitres, five millilitres. *Ans.* L 40620,005.

7. Four hundred and thirty-three kilosteres, nine hundred and eighty four hectosteres, seven thousand two hundred and three centisteres. *Ans.* S 53147203.

Rule II. When a multiple of a principal unit of measure is the unit of number; — First, *Place before the number the initial letter of the principal unit from which the multiple is derived.* Second, *Indicate the order of multiple used by a small figure placed to the left and above the letter prefixed to the number.* (See symbols in table of multiples.)

Example. 42.5 kilometres, is written ^{3}M 42.5.

The M before the number indicates that the metre is the unit of measure from which the unit of the number is derived. The small 3 indicates that the third order of multiple, or kilometre, is the unit of number.

EXAMPLES FOR PRACTICE.

Write the numbers which represent the following quantities, considering the denomination named as the unit of number: —

Unit of Number, Kilogramme.

1. 43 myriagrammes, 7 decagrammes, 5 grammes. *Ans.* ^{3}G 430.075.
2. 8 kilogrammes and 3 centigrammes. *Ans.* ^{6}G 8.00003.
3. 736 hectogrammes, 243 centigrammes, and 4 milligrammes. *Ans.* ^{3}G 73.602434.
4. 2009 hectogrammes and 3 centigrammes. *Ans.* ^{3}G 200.90003.

Unit of Number, Decalitre.

5. 254 litres and 43 millilitres. *Ans.* ^{1}L 25.4043.

6. 364 myrialitres, 47 litres, 384 millilitres. *Ans.* ^{1}L 364004.7384.
7. 243 decalitres, 47 centilitres. *Ans.* ^{1}L 243.047.

Unit of Number, Second Order of Multiples.

8. 23 myriametres, 72 millimetres. *Ans.* ^{2}M 2300.00072.
9. 4000007 steres and 2 millisteres. *Ans.* ^{2}S 40000.07002.
10. 3 kilares and 43 centiares. *Ans.* ^{2}A 30.0042.

Unit of Number, Myriametre.

11. 3 hectometres and 2 centimetres. *Ans.* ^{4}M .030002.
12. 5 millimetres. *Ans.* ^{4}M .0000005.
13. 3 decametres and 2 centimetres. *Ans.* ^{4}M .003002.

Rule III. When a submultiple of a principal unit of measure is the unit of number; — First, *Place before the number the initial letter of the principal unit from which the submultiple is derived.* Second, *Indicate the order of submultiple used by a small figure placed to the left and below the letter prefixed to the number.* (See symbols in table of submultiples.)

EXAMPLES FOR PRACTICE.

Write the numbers which represent the following quantities, considering the denomination named as the unit of number.

Unit of Number, Millimetre.

1. 32 decametres and 2 decimetres. *Ans.* $_{3}$M 320200.
2. 7002 hectometres. *Ans.* $_{3}$M 700200000.
3. 7 myriametres and 5 metres. *Ans.* $_{3}$M 70005000.
4. 3 kilometres and 2 decametres. *Ans.* $_{3}$M 3020000.

Unit of Number, Second Order of Submultiples.

5. 5 kilogrammes and 9 grammes. *Ans.* $_{2}$G 500900.
6. 302 myriasteres, 5 decasteres, and 3 centisteres. *Ans.* $_{2}$S 302005003.
7. 4009 kilolitres and 5 litres. *Ans.* $_{2}$L 400900500.
8. 2 hectares and 2 centiares. *Ans.* $_{2}$A 20002.

Unit of Number, Decilitre.

9. 3002 hectolitres and 4 millilitres. *Ans.* $_1$L 3002000.04.
10. 6 myrialitres and 1 decalitre. *Ans.* $_1$L 600.100.
11. .404 millilitres. *Ans.* $_1$L .00004.

REDUCTION.

Rule for Reduction Descending. *Multiply the given quantity by the number of the required denomination which makes a unit of the given denomination.*

Since the multiplier is always 10, 100, 1000, &c., the operation is performed by removing the decimal point as many places to the *right* as there are ciphers in the multiplier, annexing ciphers when necessary.

EXAMPLES FOR PRACTICE.

1. Reduce ^{3}M 32.58 to millimetres.
2. Reduce ^{1}M 5 to decimetres.
3. Reduce G 402 to milligrammes.
4. Reduce ^{2}A 42.3 to centiares.
5. Reduce ^{3}L 93.2 to decilitres.
6. Reduce ^{4}S 895 to decasteres.
7. Reduce ^{2}A 903.2 to milliares.
8. Reduce ^{1}G 539 to centigrammes.

Rule for Reduction Ascending. *Divide the given quantity by the number of its own denomination which makes a unit of the required denomination.*

Since the divisor is always 10, 100, 1000, &c., the operation is performed by removing the decimal point as many places to the *left* as there are ciphers in the divisor, prefixing ciphers when necessary.

EXAMPLES FOR PRACTICE.

1. Reduce $_2$A 5 to myriares.
2. Reduce $_3$M 403 to kilometres.
3. Reduce $_1$S 42.3 to hectosteres.
4. Reduce $_3$A 7.2 to decares.
5. Reduce $_3$G 3 to kilogrammes.
6. Reduce $_2$L 5.7 to hectolitres.
7. Reduce $_3$M 9 to myriametres.
8. Reduce $_2$S 47.3 to decasteres.

MEASURES OF SURFACES.

RELATIONS OF UNITS OF SURFACE TO UNITS OF LENGTH.

Decimilliare = One square decimetre = 100 square centimetres.

Milliare = { 10 square decimetres, or a plane figure whose length is one metre and breadth one decimetre.

Centiare = One square metre = 100 square decimetres.

Deciare = { 10 square metres, or a plane figure whose length is one decametre and breadth one metre.

Are = One square decametre = 100 square metres.

Decare = { 10 square decametres, or a plane figure whose length is one hectometre and breadth one decametre.

Hectare = One square hectometre = 100 square decametres.

Kilare = { 10 square hectometres, or a plane figure whose length is one kilometre and breadth one hectometre.

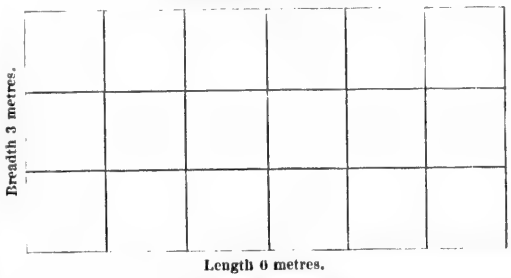
Myriare = One square kilometre = 100 square hectometres.

NUMERAL EXPRESSION FOR SURFACE.

The contents of a plane figure is expressed numerically by giving the number of times it contains some given area, which is assumed as the unit of surface.

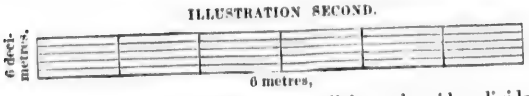
The following illustrations will show how the various denominations of the table are used in numerical expressions of surface : —

ILLUSTRATION FIRST.



It will be seen, by examining this figure, that the lines drawn parallel to the sides, at the supposed distance of a metre from each other, divide the surface into square metres, and that there are as many rows of square metres as there are metres in the breadth, each row containing as many square metres as there are metres in the length. Hence the number of square metres in the area of the figure is equal to the product of the two numbers which indicate the length and breadth ; and A 0.21 is a numerical expression for its contents.

ILLUSTRATION SECOND.

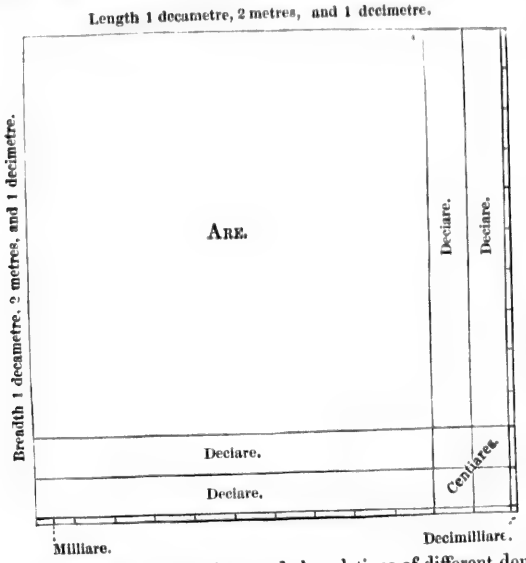


In this figure, the lines drawn parallel to the sides divide the figure into 36 milliares, or oblongs, whose length is one metre and breadth one decimetre. It is evident that ten of these oblongs put together will constitute a centiare, or square metre. Hence the expression, 36 milliares, may be written 3.6 centiares; and read, three and six tenths centiares, or three centiares and six milliares.

By reducing the length to decimetres, the numerical expression of the contents will be, by Illustration First, 60×6, or 360 decimilliares or square decimetres.

ILLUSTRATION THIRD.

Length 1 decametre, 2 metres, and 1 decimetre.



In this figure, we have illustrated the relations of different denominations of units in expressing the contents of a given surface.

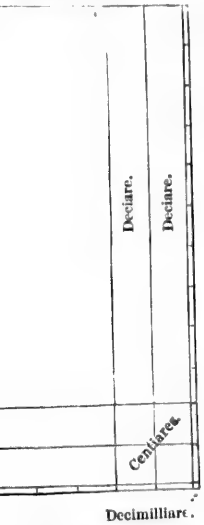
TEM.

OND.

el to the sides divide the
length is one metre and
ten of these oblongs put
are metre. Hence the ex-
centiares; and read, three
and six milliares.
he numerical expression of
60 × 6, or 360 decimilliares

RD.

nd 1 decimetre.



relations of different denomi-
nts of a given surface.

In the following analysis, each part of the contents is presented separately, as it would be obtained by multiplying the length by the breadth. The learner should carefully note each part, and analyze a sufficient number of examples to fix the principles in the mind.

ANALYSIS.

^{1}M 1.21 × ^{1}M 1.21 =	One decimetre ×	One decimetre = 1 decimilliare	= A 0.0001
		Two metres = 2 milliares	= A 0.002
		One decametre = 10 milliares = 1 centiare	= A 0.01
	Two metres ×	One decimetre = 2 milliares	= A 0.002
		Two metres = 4 centiares	= A 0.04
		One decametre = 2 deciares	= A 0.2
	One decametre ×	One decimetre = 10 milliare = 1 centiare	= A 0.01
		Two metres = 2 deciares	= A 0.2
		One decametre = 1 are or square metre	= A 1.

$$^1\text{M } 1.21 \times {}^1\text{M } 1.21 = \text{A } 1.4641$$

From these illustrations, we derive the following rule for finding a numerical expression for a given surface of uniform length and breadth: —

RULE. *Reduce the length and breadth to the same denomination: find the product of the two dimensions after reduction, and point off as many decimal places in this product as there are decimal places in the two dimensions.*

The unit of the numerical expression thus found will be a decimilliare when the unit of length is a decimetre, a centiare when the unit of length is a metre, an are when the unit of length is a decametre, a hectare when the unit of length is a hectometre, and a myriare when the unit of length is a kilometre.

EXAMPLES FOR PRACTICE.

1. How many ares in a floor M 1.25 long, and M 8.7 wide?
Ans. A .10875.

2. How many centiares, how many kilares, and how many hectares in the same floor? *Ans.* $_2$A 10.875.

3. How many ares in a board M 5.32 by $_2$M 47.?
Ans. A .025004.

4. How many milliares, how many myriares, and hectares in the same board?

5. How many metres of a carpet nine decimetres wide will cover

a floor six metres long and five and four-tenths metres wide? and what would be the cost of the carpet, at $2.50 a centiare?

Ans. M 36. $99.

6. In a farm consisting of four fields of the following dimensions, how many hectares? First field, length M 342, breadth M 273; second field, length M 634, breadth M 350; third field, length M 450, breadth M 329; fourth field, length M 730, breadth M 632.7.

Ans. ^{2}A 92.5187.

7. A pile of lumber was found to contain 150 boards M 4 long and $_1$M 4. wide, 225 boards M 6.2 long and $_2$M 52. wide, and 642 boards M 5.2 long and $_2$M 43 wide. How much was it worth, at $42. per are, face measure. *Ans.* $1008.38 +.

8. How many bricks $_1$M 2.2 × $_1$M 1.1 would pave a side-walk M 842.6 long and M 2.2 wide? and what would be the whole cost at 82 cents per centiare. *Ans.* 76600 bricks. $1520.05 +.

MEASURES OF VOLUMES, OR SOLIDS.

RELATIONS OF UNITS OF VOLUMES TO UNITS OF LENGTHS.

Millistere = A cubic decimetre = 1000 cubic centimetres.

Centistere = 10 cubic decimetres, or a volume, or solid, whose length is one metre, and breadth and thickness one decimetre.

Decistere = 10 centisteres = 100 cubic decimetres, or a volume whose length and breadth is one metre, and thickness one decimetre.

Stere = A cube metre = 10 decisteres = 100 centisteres = 1000 millisteres or cubic decimetres.

Decastere = 10 cubic metres, or a volume whose length is one decametre, and breadth and thickness one metre.

Hectostere = 10 decasteres = 100 cubic metres, or a volume whose length and breath is one decametre, and thickness one metre.

Kilostere = A cubic decametre = 1000 cubic metres.

Myriastere = 10 kilosteres, or a volume whose length is one hectometre, and breadth and thickness each one decametre.

-tenths metres wide? and
2.50 a centiare?
Ans. M 36. $99.
f the following dimensions,
M 342, breadth M 273;
350; third field, length
M 730, breadth M 632.7.
Ans. ^{2}A 92.5187.
ntain 150 boards M 4 long
and $_2$M 52. wide, and 642
much was it worth, at $42.
Ans. $1008.38 +.
1 would pave a side-walk
t would be the whole cost
bricks. $1520.05 +.

S, OR SOLIDS.

TO UNITS OF LENGTHS.

0 cubic centimetres.
a volume, or solid, whose
l breadth and thickness one

ic decimetres, or a volume
lth is one metre, and thick-

teres = 100 centisteres =
ic decimetres.
olume whose length is one
and thickness one metre.
e metres, or a volume whose
ne decametre, and thickness

00 cubic metres.
e whose length is one hecto-
nd thickness each one deca-

NUMERICAL EXPRESSION FOR VOLUME, OR SOLIDITY.

The solidity, or contents, of a volume is expressed numerically by giving the number of times it contains some given solid as the unit of volume.

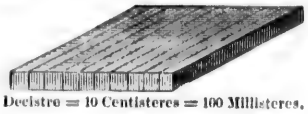
The following illustrations will show how the various denominations of the table are used in numerical expressions of volume.

Millistere, or Cubic Decimetre.

10 millisteres, placed side by side, make a volume whose length is one metre, and breadth and thickness each one decimetre, thus, —

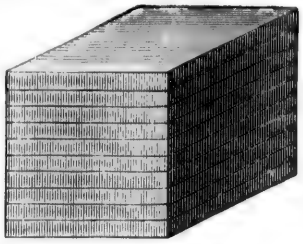
Centistere = 10 Millisteres.

10 centistere, placed side by side, make a volume whose length and breadth is each one metre, and thickness one decimetre, thus, —



Decistre = 10 Centisteres = 100 Millisteres.

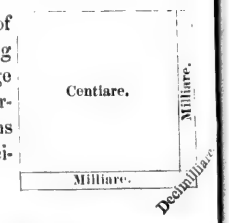
10 decisteres, placed face to face, make a cube whose edge is one metre, thus, —



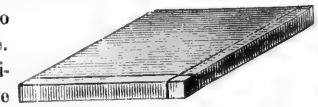
Stere = 10 Decisteres = 100 Centisteres = 1000 Millisteres.

From these illustrations, it is evident that the contents of a cubic metre may be expressed numerically, as S 1, $_1$S 10, $_2$S 100, $_3$S 1000.

The following figures illustrate the use of the same four denominations in expressing the contents of a cubic volume whose edge is one metre and one decimetre. The surface of one face of the volume contains one centiare, two milliares, and one decimilliare, thus, —



Taking a slab of the face one decimetre thick, thus, — and we have one decistere, two centisteres, and one millistere. But the volume is eleven decimetres thick; therefore we have eleven such slabs, or eleven times one decistere, two centisteres, and one millistere.



$$= \begin{cases} 11 \text{ millisteres} = 1 \text{ centistere and } 1 \text{ millistere} = \text{S } 0.011 \\ 22 \text{ centisteres} = 2 \text{ decisteres and } 2 \text{ centisteres} = \text{S } 0.22 \\ 11 \text{ decisteres} = 1 \text{ stere and } 1 \text{ decistere} = \text{S } 1.1 \end{cases}$$

$$\text{M } 1.1 \times \text{M } 1.1 \times \text{M } 1.1 = \text{S}1.331$$

From these illustrations, we derive the following rule for finding a numerical expression for a given volume of uniform length, breadth, and thickness: —

Rule. *Reduce the length, breadth, and thickness to the same denomination; find the product of the three dimensions, after reduction, and point off as many decimal places in this product as there are decimal places in the three dimensions.*

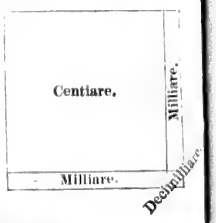
The unit of the numerical expression thus found will be a millistere when the unit of length is a decimetre, a stere when the unit of length is a metre, a kilostere when the unit of length is a decametre.

EXAMPLES FOR PRACTICE.

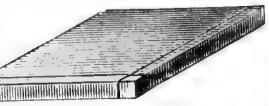
1. How many steres in a wall twenty-four metres long, eight and five-tenth metres high, and fifty-two centimetres thick? And what would be the cost of building it, at $4.25 a stere?

Ans. S 106.08. Cost, $450.84.

e use of
pressing
se edge
he sur-
contains
ne deci-



netre thick, thus, —



ne decistere, two centisteres, and

and 1 millistere	= S 0.011
s and 2 centisteres	= S 0.22
1 decistere	= S 1.1
I 1.1 × M 1.1	= S1.331

e the following rule for finding a
ume of uniform length, breadth,

dth, and thickness to the same
f the three dimensions, after re-
cimal places in this product as
e dimensions.

ion thus found will be a millistere
re, a stere when the unit of length
t of length is a decametre.

R PRACTICE.

wenty-four metres long, eight and
o centimetres thick? And what
$4.25 a stere?
s. S 106.08. Cost, $450.84.

2. What would be the cost of a pile of wood fifteen and seven-tenths metres long, three metres high, and seven and fifty-two hundredths metres wide, at $1.50 a stere? *Ans.* $885.48.

3. What would be the cost of excavating a cellar eighteen and three-tenths metres long, ten and seventy-three hundredths metres wide, and three and four-tenths metres deep, at 15 cents per stere? *Ans.* $100.14 +.

4. How deep must a box be, whose surface is thirty-two milliares, to contain seven and thirty-six hundredths steres? *Ans.* $_1$M 23.

5. How many steres in five sticks of timber of the following dimensions: First, $_1$M 5.2 by $_1$M 7.3, and M 13 long; second, $_2$M 43. by $_2$M 65, and M 17.5 long; third, $_1$M 5.3 by $_1$M 3.7, and M 15.42 long; fourth, $_2$M 39 by $_2$M 56, and M 14 long; fifth, $_1$M 4.52 by $_1$M 3.78, and M 15 long. *Ans.* S 18.470352.

6. What must be the height of a load of wood, M 3.2 long and M 1.1 wide, to contain S 4.0128. *Ans.* M 1.14.

MEASUREMENT OF ANGLES.

In the ordinary or sexagesimal system, a right-angle, which is used as the measure of all plane angles, is divided into 90 equal parts, called degrees; a degree is divided into 60 equal parts, called minutes; and a minute into 60 equal parts, called seconds.

In the centesimal or French system, a right-angle is divided into 100 equal parts, called grades; a grade into 100 equal parts, called minutes; and a minute into 100 equal parts, called seconds.

The former is called the *sexagesimal* system, on account of the occurrence of the number *sixty* in forming the subdivisions of a degree; and the latter *centesimal*, on account of the occurrence of the number *one hundred.*

Grades, minutes, and seconds are usually written thus: $35^g\ 42'\ 24''$; read, thirty-five grades, forty-two minutes, twenty-four seconds.

Since the scale is centesimal, minutes may be expressed as hundredths, and seconds as ten-thousandths; hence any number of grades, minutes, and seconds may be expressed decimally thus: $73^g\ 4569$; read, seventy-three grades, forty-five minutes, sixty-nine seconds.

In a right-angle, there are 100 grades, or 90 degrees; hence, for every 10 grades there are 9 degrees. Dividing the 10 grades into 9 equal parts or degrees, each part will contain $1\frac{1}{9}$ grades; therefore a degree is equal to $1\frac{1}{9}$ grades. Hence, in any number of grades there are as many degrees as $1\frac{1}{9}$ is contained times in the given number of grades; and, conversely, in any number of degrees there are $1\frac{1}{9}$ times as many grades as there are degrees. Hence the following rules: —

TO CHANGE THE CENTESIMAL MEASURE TO THE SEXAGESIMAL.

RULE. *Express the minutes and seconds as a decimal of a grade; divide by $1\frac{1}{9}$: the quotient will express the number of degrees and decimals of a degree in the given number of grades, minutes, and seconds.*

EXAMPLES.

Change the following quantities from the centesimal measure to the sexagesimal.

1. $25^g\ 34'\ 42''$. *Ans.* $22°\ 48'\ 35.208''$.
2. $57'\ 93''$. *Ans.* $31'\ 16.932''$.
3. $83^g\ 13'\ 87''$. *Ans.* $74°\ 49'\ 29.388''$.
4. $36^g\ 98'\ 15''$. *Ans.* $33°\ 17'\ .06''$.
5. $14^g\ 15'\ 60''$. *Ans.* $12°\ 44'\ 25.44''$.
6. $90^g\ 90'\ 90''$. *Ans.* $81°\ 49'\ 5.16''$.
7. $18^g\ 50'\ 25''$. *Ans.* $16°\ 39'\ 8.1''$.

TO CHANGE THE SEXAGESIMAL MEASURE TO THE CENTESIMAL.

RULE. *Reduce the minutes and seconds to a decimal of a degree; multiply the degrees and decimal of a degree by $1\frac{1}{9}$: the product is the number of grades, minutes, and seconds in the given number of degrees, minutes, and seconds.*

EXAMPLES.

Change the following quantities from the sexagesimal measure to the centesimal.

1. $36°\ 18'\ 27''$. *Ans.* $40^g\ 34'\ 16\frac{2}{3}''$.
2. $56'\ 54''$. *Ans.* $1^g\ 5'\ 37\frac{1}{27}''$.

3. $27° 36' 45''$. *Ans.* $30^g 68^s 5\frac{5}{9}^m$.
4. $189° 15' 20''$. *Ans.* $210^g 28^s 39\frac{41}{81}^m$.
5. $63° 14' 58''$. *Ans.* $70^g 27^s 71\frac{49}{81}^m$.
6. $147° 24' 48''$. *Ans.* $163^g 79^s 25\frac{25}{27}^m$.
7. $117° 36' 54''$. *Ans.* $130^g 68^s 33\frac{1}{3}^m$.

TO CHANGE THE METRIC TO THE COMMON SYSTEM.

RULE. *Reduce the given quantity to the denomination of the principal unit of the table; multiply by the equivalent, and reduce the product to the required denomination.*

1. ^{3}M 3.6, how many feet?

OPERATION.

^{3}M 3.6 × 1000 = M 3600
39.37 in. × 3600 = 141732 in.
141732 in. ÷ 12 in. = 11811 ft.

ANALYSIS. — The metre is the principal unit of the table; hence we reduce the kilometres to metres. Since there are 39.37 inches in a metre, in 3600 metres there are 3600 times 39.37 inches; and since there are 12 inches in a foot, there are as many feet as 12 inches is contained times in 141732 inches. Therefore ^{3}M 3.6 is equal to 11811 feet.

EXAMPLES FOR PRACTICE.

2. How many feet in 472 centimetres? *Ans.* $15.4855\frac{1}{3}$ ft.
3. How many cubic feet in 2 kilosteres? *Ans.* 70632 cu. ft.
4. How many gallons, wine measure, in 325 decilitres?
Ans. 8 gals. 2.343 — qts.
5. How many gallons in 108.24 litres? *Ans.* 28.594 + gals.
6. How many bushels in 3262 kilolitres?
Ans. 92559.25 bush.
7. How many square yards in 436 ares?
Ans. 52145.6 sq. yds.
8. In 942325 centilitres, how many bushels?
Ans. 267.3847 + bush.
9. In 436 myriagrammes, how many pounds?
Ans. 9611.9314 lbs.

TO CHANGE FROM THE COMMON TO THE METRIC SYSTEM.

RULE. *Reduce the given quantity to the denomination in which the equivalent of the principal unit of the metric table is expressed; divide by this equivalent, and reduce the quotient to the required denomination.*

1. In 10 lbs. 4 oz. how many myriagrammes?

OPERATION.

10 lbs. 4 oz. = 10.25 lbs.
10.25 lbs. × 7000 = 71750 gr.
71750 gr. ÷ 15.432 gr. = G 4649.43 —
G 4649.43 — ÷ 10000 = ^{4}G .464943 — *Ans.*

ANALYSIS. — The gramme, the principal unit of the table, is expressed in grains; hence we reduce the pounds and ounces to grains 15.432 grains make one gramme; hence there are as many grammes in 71750 grains as 15.432 grains is contained times in 71750 grains. And since there are 10000 grammes in a myriagramme, dividing G 4649.43 — by 10000 will give the myriagrammes in 10 pounds 4 ounces. Therefore, 10 lbs. 4 oz. is equal to ^{4}G 464943 —

EXAMPLES FOR PRACTICE.

2. In 6172.8 pounds, how many decagrammes?
Ans. ^{1}G 280000.

3. How many hectares in 2392 square yards? *Ans.* ^{2}A .2.

4. How many ares in a square mile?
Ans. A 25899.665552 —.

5. How many millisteres in 18924 cubic yards?
Ans. $_{3}$S 14467889.9082 +.

6. In 892 grains, how many hectogrammes?
Ans. ^{2}G .578019.

7. In 2 miles, 6 furlongs, 39 rods, and 5 yards, how many kilometres? *Ans.* ^{3}M 4.626416 +.

8. Bought 454 bush. wheat at $3, and sold the same at $8.75 per hectolitre; how many hectolitres did I sell? Did I gain or lose and how much?
Ans. ^{2}L 160. Gain, $38.

MISCELLANEOUS EXAMPLES.

Required the footings of the following bills: —

(1.)

NEW YORK, April 23, 1867.

W. J. MILNE,

Bo't of L. COOLEY & SON.

M 122 Broadcloth,	@	$6.00	
" 320 Bld. Shirting,	"	.35	
" 230 White Flannel,	"	.30	
" 206.5 Ticking,	"	.31	
" 107.9 Blk. Silk,	"	2.40	
	Ans.		$1235.975

Rec'd Payment,

L. COOLEY & SON.

(2.)

BUFFALO, May 1, 1867.

CHAS. D. MCLEAN,

Bo't of WM. BENEDICT.

40 chests Tea,	each	^{3}G 30.5	@	$ 2.50
12 sacks Java Coffee,			"	40.00
25 bbls. Coffee Sugar,	each	^{3}G 110	"	.32
10 " Crushed "	"	^{3}G 95	"	.38
30 boxes Raisins,	"	^{3}G 12	"	.50
			Ans.	$4951.00

Rec'd Payment,

WM. BENEDICT.

3. A man bought a lot of land ^{2}M 40 long and ^{2}M 20 wide, and sold one-third of it. How many ares had he left, and what was the cost of the lot, at $100 per acre?

Ans. to first, A 53333.33⅓. *Ans. to second*, $66889.63 +.

4. A farmer sold ^{2}L 540 of wheat at $6, and invested the proceeds in coal at $8 per ton. How many myriagrammes of coal did he purchase? *Ans.* ^{4}G 36741.835147 +.

5. What will be the cost of a pile of wood M 42.5 long, M 2. high, M 1.9 wide, at $2 per stere? *Ans.* $323.

6. How many metres of shirting, at \$.25 per metre, must be given in exchange for ^{2}L 300 oats, at \$1.20 per hectolitre?

Ans. 1440 yds.

7. A grocer buys butter at \$.28 per lb., and sells it at \$.60 per kilogramme. Does he gain or lose, and what per cent.?

Ans. Lost $2\frac{514}{643}$ %.

8. A bin of wheat measures M 5 square, and M 25 deep. How many hectolitres will it contain, and what will be the cost of the wheat, at \$2 per bushel? *Ans.* ^{2}L 625. \$3546.875.

9. What price per pound is equivalent to \$2.50 per ^{2}G?

Ans. \$11.34.

10. A merchant bought M 240 of silk at \$2, and sold it at \$1.95 per yard. Did he gain or lose, and how much?

Ans. Gain \$31.81.

11. Find the measure of $1^{\prime}\ 5^{\prime\prime}$ in decimals of a degree.

Ans. .00945.

12. A merchant shipped to France 50 bbls. of coffee sugar, each containing 250 lbs., paying \$2 per hundred for transportation. He sold the sugar at \$.34 per kilogramme, and invested the proceeds in broadcloth at \$4 per metre. How many yards of broadcloth did he purchase?

Ans. 458.71 + yds.

13. The difference between two angles is 10 grades, and their sum is 45°. Find each angle. *Ans.* 18° and 27°.

14. Determine the number of degrees in the unit of angular measure when an angle of $66\frac{2}{3}$ grades is represented by 20.

Ans. 3°.

15. How many centiares of plastering in a house containing six rooms of the following dimensions, deducting one-twelfth for doors, windows, and base? and what would be the cost of the work at 38 cents per centiare? First room, M 6.2 × M 4.7; second room, M 4.52 × M 4; third room, M 6 × M 5.2; fourth room, M 3.82 × M 3.82; fifth room, M 7 × M 6.2; sixth room, M 4.5 × M 4.25. Height of each room, M 3.8. *Ans.* $_2$A 558.9406 +. \$212.40 —.

5 per metre, must be
r hectolitre?
Ans. 1440 yds.
nd sells it at $.60 per
per cent.?
Ans. Lost $2\frac{514}{643}$ %.
and M 25 deep. How
vill be the cost of the
.625. $3546.875.
$2.50 per ²G?
Ans. $11.34.
2, and sold it at $1.95
h?
Ans. Gain $31.81.
s of a degree.
Ans. .00945.
ls. of coffee sugar, each
for transportation. He
invested the proceeds in
ds of broadcloth did he
Ans. 458.71 + yds.
is 10 grades, and their
Ans. 18° and 27°.
in the unit of angular
resented by 20.
Ans. 3°.
n a house containing six
ng one-twelfth for doors,
e cost of the work at 38
× M 4.7; second room,
; fourth room, M 3.82 ×
room, M 4.5 × M 4.25.
9406 +. $212.40 —.

PERCENTAGE.

The following pages on Percentage are taken from ROBINSON'S HIGHER ARITHMETIC, and will be found of practical value to the student and the business man.

Several pages, on the different kinds of *U. S. Securities, Bonds, Treasury Notes, Gold Investments, Currency, &c.*, with *Practical Examples*, have recently been inserted.

This change and addition will not interfere, in the use of the use of the book, with previous editions of the same.

40
prosec
incorp
40
to act
40
the p
40
compa
Nor
is also
40
tribut
40
incor
40
ment
titles
4
stock
tion
and
4
title
comp
Nor
a gen
being

STOCKS.

463. A **Company** is an association of individuals for the prosecution of some industrial undertaking. Companies may be incorporated or unincorporated.

464. A **Corporation** is a body formed and authorized by law to act as a single person.

465. A **Charter** is the legal act of incorporation, and defines the powers and obligations of the incorporated body.

466. A **Firm** is the name under which an unincorporated company transacts business.

NOTE.—A private banking company, or a manufacturing or commercial firm is also called a *House*.

467. The **Capital Stock** of a corporation is the money contributed and employed to carry on the business of the company.

468. **Joint Stock** is the money or capital of any company, incorporated or unincorporated.

469. **Scrip** or **Certificates of Stock** are the papers or documents issued by a corporation, giving the members their respective titles or claims to the joint capital.

470. A **Share** is one of the equal parts into which capital stock is divided. The value of a share in the original contribution of capital varies in different companies; in bank, insurance, and railroad companies of recent organization, it is usually $100.

471. **Stockholders** are the owners of stock, either by original title or by subsequent purchase. The stockholders constitute the company.

NOTES.—1. The capital stock of any corporation is limited by the charter. As a general rule, only a portion is paid at the time of subscription, the residue being reserved for future outlays or disbursements.

2. When the capital stock has been all paid in, money may be raised, if necessary, by *loans*, secured by mortgage upon the property. The *bonds* issued for these loans entitle the holders to a fixed rate of interest.

3. Stocks, as a general name, applies to the scrip and bonds of a corporation, to government bonds and public securities, and to all paper representing joint capital or claims upon corporate bodies.

4. The members of an incorporated company are individually liable for the debts and obligations of the company, to the amount of their interest or stock in the company, and to no greater amount. But the members of a firm or house are individually liable for all the debts and obligations of the company, without regard to the amount of their share or interest in the concern.

The calculations of percentage in stocks are treated in this work under the heads of

Stock-jobbing, Assessments and Dividends, and Stock Investments.

STOCK-JOBBING.

472. **Stock-jobbing** is the buying and selling of stocks with a view to realize gain from their rise and fall in the market.

473. The **Nominal** or **Par value** of stock is the sum for which the scrip or certificate is issued.

474. The **Market** or **Real value** of stock is the sum for which it will sell.

475. Stock is **At Par** when it sells for its first cost, or nominal value.

476. Stock is **Above Par,** at a premium or advance, when it sells for more than its nominal value.

477. Stock is **Below Par,** or at a discount, when it sells for less than its nominal value.

NOTE.—When the business of a company pays large profits to the stockholders, the stock will be worth more than its original cost; but when the business does not pay expenses, the value of the stock will be less than its original cost. The average market value of stock generally varies directly as the rate of profit which the business pays.

478. A **Stock Broker** is a person who buys and sells stocks, either for himself, or as the agent of another.

NOTE.—A person employed by a manufacturer, wholesale dealer, or commission merchant, to seek customers and close bargains, at or from his place of business, is called a *broker*, of the class or kind corresponding to his business.

479. **Brokerage** is the fee or compensation of a broker.

480. The calculations in stock-jobbing are based upon the following relations:

I. Premium, discount, and brokerage are each a *percentage*, computed upon the par value of the stock as the *base*.

II. The market value of stock, or the proceeds of a sale, is the *amount* or *difference*, according as the sum is greater or less than the par value.

NOTE 1.—In all examples relating to stocks, $100 will be considered a share, unless otherwise stated.

EXAMPLES FOR PRACTICE.

1. What cost 54 shares of Reading Railroad stock, at 4½ % premium?

OPERATION.

$5400 × .045 = $243, premium.
$5400 + $243 = 5643, *Ans.*

Or,

5400 × $1.045 = $5643, *Ans.*

ANALYSIS. We first compute the premium upon the par value of the stock, and find it to be $243; adding this to the $5400, we obtain the cost, or market value, $5643. Or, since every dollar of the stock will cost $1 plus the premium, or $1.045, $5400 will cost 5400 × $1.045 = $5643.

2. What do I receive for 32 shares of telegraph stock, which a broker sells for me at 15 % discount charging ¼ % brokerage?

OPERATION.

.15 + .0025 = .1525
$1.00 — $.1525 = $.8475 proceeds of $1 of stock.
3200 × $.8475 = $2712, *Ans.*

ANALYSIS. Adding the rate of brokerage to the rate of discount, we have .1525; hence $1 will bring $1—$.1525= $.8475, and $3200 will bring 3200 × $.8475 = $2712.

3. I put $35400 into the hands of a broker to be invested in Missouri State Bonds, when their market value is 12 % below par; how many shares shall I receive, if the broker charges ½ % for his services?

OPERATION.

$1.00 — $.12 = $.88, market value of $1.
$ .88 + $.00½ = .885, cost of $1.
$35400 ÷ .885 = $40000 = 400 shares, *Ans.*

ANALYSIS. Since the stock is 12 % below par, the market value of $1 is $.88; adding the rate of brokerage, we find that every dollar of

the stock will cost me $.885. Hence for $35400 the broker can buy $35400 ÷ .885 = $40000 = 400 shares.

NOTES. — 2. The rate of brokerage in New York city has been fixed by custom at ¼ per cent.

3. Since brokerage has the same base as the premium or discount, the *rate* of brokerage may always be combined with the rate of premium or discount, by addition or subtraction, as the nature of the question may require.

4. The price of stock is usually quoted at a certain per cent. of the *face*, or nominal value. Thus stock at 4 % above par is quoted at 104 %; stock at 5 % below par is quoted at 95 %; and so on.

4. What is the market value of 15 Ohio State bonds at 112 %? *Ans.* $1680.

5. What shall I realize on 20 shares of Panama railroad stock at 135 %, brokerage at 1¾ %? *Ans.* $2665.

6. My agent bought for me 120 shares of N. Y. Central railroad stock, paying 80¾ %, and charging brokerage at ½ %; what did the stock cost me? *Ans.* $9750.

7. What cost 36 shares in the Merchants' Bank, at a premium of 7½ %, brokerage ¼ %?

8. A speculator invested $21910 in shares of the Harlem railroad, at a discount of 60¾ %; how many shares did he buy?

9. If 400 shares of the Bank of Commerce sell for $40150, what is the rate of premium? *Ans.* ⅜ %.

10. A broker receives $48447 to be invested in bonds of the Michigan Central railroad, at 94⅞ %; how much stock can he buy, allowing 1¼ % brokerage?

11. My agent sells 830 barrels of Genesee flour at $6 per barrel, commission 5 %, and invests the proceeds in stock of the Pennsylvania Coal Company, at 82¾ %, charging ¼ % for making the purchase; how many shares do I receive? *Ans.* 57.

12. I purchased 18 shares of Ocean Telegraph stock, par value $500 per share, at a premium of 2 %, and sold the same at a discount of 28 %; what was my loss? *Ans.* $2700.

NOTE 5. — The rate of loss is .02. + .28 = .30, or .30 %.

13. A speculator exchanged $3600 of railroad bonds, at 5 % discount, for 27 shares of stock of the Suffolk Bank, at 3 % premium, receiving the difference in cash; how much money did he receive?

14. A merchant owning 525 shares in the American Exchange

Bank, worth 104 %, exchanges them for United States bonds worth 105 %; how much of the latter stock does he receive?

15. I purchased 12 shares of stock at a premium of 5 %, and sold the same at a loss of $96; what was the selling price?

16. Having bought $64000 stock in the Cunard Line, at 2 % premium, at what price must I sell it, to gain $2560?

Ans. 106 %.

17. A speculator bought 250 shares in a Carson Valley mining company at 103 %, and 150 shares of the Western Railroad stock at 95 %; he exchanged the whole at the same rates, for shares in the N. Y. Central Railroad at 80 %, which he afterward sold at 85 %. How much did he gain? *Ans.* $2500.

18. I purchased stock at par, and sold the same at 3 % premium, thereby gaining $750; how many shares did I purchase?

19. A broker bought Illinois State bonds at 103 %, and sold at 105 %. His profits were $240; what was the amount of his purchase? *Ans.* $12000.

20. A man invested in mining stock when it was 4 % above par, and afterward sold his shares at 5½ % discount. His loss in trade was $760; how many shares did he purchase?

21. I invested $6864 in Government bonds at 106 %, paying 1¼ % brokerage, and afterward sold the stock at 112 %, paying 1½ % brokerage; what was my gain? *Ans.* $268.

22. How much money must be invested in stocks at 3 % advance, in order to gain $480 by selling at 7 % advance?

23. How many shares of stock must be sold at 4 % discount, brokerage ½ %, to realize $4775? *Ans.* 50.

INSTALLMENTS, ASSESSMENTS, AND DIVIDENDS.

481. An **Installment** is a portion of the capital stock required of the stockholders, as a payment on their subscription.

482. An **Assessment** is a sum required of stockholders, to meet the losses or the business expenses of the company.

483. A **Dividend** is a sum paid to the stockholders from the profits of the business.

484. **Gross Earnings** are all the moneys received from the regular business of the company.

485. **Net Earnings** are the moneys left after paying expenses, losses, and the interest upon the bonds, if there be any.

486. In the division of the net earnings, or the apportionment of dividends and assessments, the calculations are made by finding the rate per cent. which the sum to be distributed or assessed bears to the entire capital stock. Hence,

487. Dividends and assessments are a *percentage* computed upon the par value of the stock as the *base*.

EXAMPLES FOR PRACTICE.

1. The Long Island Insurance Company declares a dividend of 6 %; what does A receive, who owns 14 shares?

OPERATION.
$1400 × .06 = $84

ANALYSIS. According to **449**, we multiply the base, $1400, by the rate, .06, and obtain the dividend, $84.

2. A canal company whose subscribed funds amount to $84000, requires an installment of $6300; what per cent. must the stockholders pay?

OPERATION.
$6300 ÷ 84000 = .07½

ANALYSIS. According to **450**, we divide the installment, $6300, which is *percentage*, by the *base*, $84000, and obtain the rate, .07½ = 7½ %.

3. A man owns 56 shares of railroad stock, and the company has declared a dividend of 8 %; what does he receive? *Ans.* $448.

4. I own $15000 in a mutual insurance company; how many shares shall I possess after a dividend of 6 % has been declared, payable in stock? *Ans.* 159 shares.

5. The Pittsburgh Gas Company declares a dividend of 15 %; what will be received on 65 shares?

6. A received $600 from a 4 % dividend; how much stock did he own? *Ans.* $15000.

7. The paid-in capital of an insurance company is $536000. Its receipts for one year are $99280, and its losses and expenses are $56400; what rate of dividend can it declare? *Ans.* 8 %.

8. The net earnings of a western turnpike are $3616, and the amount of stock is $56000; if the company declare a dividend of 6 %, what surplus revenue will it have? *Ans.* $256.

9. The capital stock of the Boston and Lowell Railroad Co. is $1830000, and its debt is $450000. Its gross earnings for the year 1858 were $407399, and its expenses $217621. If the company paid expenses, and interest on its debt at $5\frac{5}{9}$ %, and reserved $78, what dividend would a stockholder receive who owned 30 shares? *Ans.* $270.

10. The charter of a new railroad company limits the stock to $800,000, of which 3 installments of 10 %, 25 %, and 35 %, respectively, have been already paid in. The expenditures in the construction of the road have reached the sum of $540,000, and the estimated cost of completion is $400,000. If the company call in the final installment of its stock, and assess the stockholders for the remaining outlay, what will be the rate %? *Ans.* $17\frac{1}{2}$.

11. The Bank of New York, having $156753.19 to distribute to the stockholders, declares a dividend of $5\frac{1}{4}$ %; what is the amount of its capital? *Ans.* $2,985,775 nearly.

12. The passenger earnings of a western railroad in one year were $574375.25, the freight and mail earnings were $643672.36, the whole amount of disbursements were $651113.53, and the company was able to declare a dividend of 8 %; how much scrip had the company issued? *Ans.* $7086676.

13. Having received a stock dividend of 5 %, I find that I own 504 shares; how many shares had I at first? *Ans.* 480.

14. I received a 6 % dividend on Philadelphia City railroad stock, and invested the money in the same stock at 75 %. My stock had then increased to $16200; what was the amount of my dividend? *Ans.* $900.

15. A ferry company, whose stock is $28000, pays 5 % dividends semi-annually. The annual expenses of the ferry are $2950; what are the gross earnings? *Ans.* $5750.

STOCK INVESTMENTS.

488. The net earnings of a corporation are usually divided among the stockholders, in semi-annual dividends. The income of *capital stock* is therefore fluctuating, being dependent upon the condition of business; while the income arising from *bonds*, whether of government or corporations, is fixed, being a certain rate per cent., annually, of the par value, or face of the bonds.

489. Federal or United States Securities are of two kinds: viz., Bonds and Notes.

Bonds are of two kinds.

First, Those which are payable at a fixed date, and are known and quoted in commercial transactions by the rate of interest they bear, thus,: U. S. 6's, that is, United States Bonds bearing 6 % interest.

Second, Those which are payable at a fixed date, but which may be paid at an earlier specified time, as the Government may elect. These are known and quoted in commercial transactions by a combination of the two dates, thus: U. S. 5–20's, or a combination of the rate of interest and the two dates, thus: U. S. 6's 5–20; that is, bonds bearing 6 % interest, which are payable in twenty years, but may be paid in five years, if the Government so elect.

When it is necessary, in any transaction, to distinguish from each other different issues which bear the same rate of interest, this is done by adding the year in which they become due, thus: U. S. 5's of '71; U. S. 5's of '74; U. S. 6's 5–20 of '84; U. S. 6's 5–20 of '85.

Notes are of two kinds.

First, Those payable on demand, without interest, known as United States Legal-tender Notes, or, in common language, "Green Backs."

Second, Notes payable at a specified time, with interest, known as Treasury Notes. Of these, there are two kinds, — Six-per-cent. Compound-interest Notes, and Notes bearing $7\frac{3}{10}$ % interest, the latter known and quoted in commercial transactions as 7.30's.

on are usually divided
lends. The income of
lependent upon the con-
from *bonds*, whether of
certain rate per cent.,
nds.
rities are of two kinds:

d date, and are known
he rate of interest they
es Bonds bearing 6 %

ed date, but which may
Government may elect.
transactions by a combi-
, or a combination of the
J. S. 6's 5–20; that is,
able in twenty years, but
t so elect.
to distinguish from each
rate of interest, this is
me due, thus: U. S. 5's
of '84; U. S. 6's 5–20

hout interest, known as
mmon language, "Green

me, with interest, known
vo kinds, — Six-per-cent.
ing $7\frac{3}{10}$ % interest, the
sactions as 7.30's.

The nomenclature here explained is the one used in commercial transactions, which involve similar securities of States or corporations.

The interest on all bonds is payable in gold.

The interest on notes is payable in Legal-tender Notes.

When Bonds or Stocks are sold, a revenue stamp must be used equal in value to one cent on each $100, or fraction of $100, of their currency value. If sold by a broker, this is charged to the person for whom they are sold.

The following are the principal United States Securities: —

BONDS.

U. S. 6's of 1867.
U. S. 6's of 1868.
U. S. 6's of 1880.
U. S. 6's of 1881.
U. S. 5's of 1871.
U. S. 5's of 1874.
U. S. 5–20's, due in 1882, interest 5 %.
U. S. 5–20's, due in 1884, interest 6 %.
U. S. 5–20's, due in 1885, interest 6 %.
U. S. 10–40's, due in 1904, interest 5 %.
Pacific Railroad 6's of 1895.
Pacific Railroad 6's of 1896.

NOTES.

Compound-interest Notes of 1867.
Compound-interest Notes of 1868.
7.30 Notes of 1867.
7.30 Notes of 1868.

CASE I.

490. To find what income any investment will produce.

1. What income will be obtained by investing $6840 in stock bearing 6 %, and purchased at 95 %?

OPERATION.

$6840 ÷ .95 = $7200, stock purchased.
$7200 × .06 = $432, annual income.

ANALYSIS. We divide the investment, $6840, by the cost of $1, and obtain $7200, the stock which the investment will purchase, (**452**). And since the stock bears 6 % interest, we have $7200 × .06 = $432, the annual income obtained by the investment. Hence,

RULE. — *Find how much stock the investment will purchase, and then compute the income at the given rate upon the par value.*

EXAMPLES FOR PRACTICE.

1. The trustees of a school invested $35374.80 in the U. S. 5 % bonds as a teachers' fund, purchasing the stock at 102½ %; if the salary of the Principal be $1000, what sum will be left to pay assistants? *Ans.* $725.60.

2. A young man, receiving a legacy of $48000, invested one half in 5 % stock at 95½ %, and the other half in 6 % stock at 112 %, paying brokerage at ½ %; what annual income did he secure from his legacy? *Ans.* $2530.

3. I have 32300 to invest, and can buy New York Central 6's at 85 %, or New York Central 7's at 95 %; how much more profitable will the latter be than the former, per year?

4. A owns a farm which rents for $411.45 per annum. If he sell the same for $8229, and invest the proceeds in U. S. 5–20's of '84, at 105 %, paying ½ % brokerage, will his yearly income be increased or diminished, and how much? *Ans.* Increased $56.55.

5. A sold $8700 of U. S. 5–20's of '84 at 104 %, paying for necessary revenue stamps, and invested the proceeds in U. S. 10–40's at 94 %, brokerage ½ % both for selling and buying. Did he gain or lose by the exchange, and how much annually? *Ans.* $45.62—.

CASE II.

491. To find what sum must be invested to obtain a given income.

1. What sum must be invested in Virginia 5 per cent. bonds, purchasable at 80 %, to obtain an income of $600?

OPERATION.

$600 ÷ .05 = $12000, stock required.
$1200 × .80 = $9600, cost or investment.

ANALYSIS. Since $1 of the stock will obtain $.05 income, to obtain $600 will require $600 ÷ .05 = $12000, (Case 1). Multiplying the par value of the stock by the market price of $1, we have $12000 × .80 = $9600, the cost of the required stock, or the sum to be invested. Hence the

RULE. I. *Divide the given income by the % which the stock pays: the quotient will be the par value of the stock required.*

II. *Multiply the par value of the stock by the market value of one dollar of the stock; the product will be the required investment.*

EXAMPLES FOR PRACTICE.

1. If Missouri State 6's are 16 % below par, what sum must be invested in this stock to obtain an income of $960?

2. What sum must I invest in U. S. 5–20's of '82 at 96¾ %, brokerage ¼ %, to secure an annual income of $1500.
Ans. $29100.

3. How much must I invest in U. S. 7–30's, at 106 %, that my annual income may be $1752? *Ans.* $25440.

4. If I sell $15600 U. S. 10–40's at 97 %, and invest a sufficient amount of the proceeds in U. S. 5–20's of '85 at 107 % to yield an annual income of $540, and buy a house with the remainder, how much will the house cost me? Ans. $5502.

5. Charles C. Thomson, through his broker, invested a certain sum of money in U. S. 6's 5–20 at 107 %, and twice as much in U. S. 10–40's at 98½ %, brokerage in each case ½ %. His income from both investments was $1674. How much did he invest in each kind of stock?
Ans. First kind, $10692. Second kind, $21384.

CASE III.

492. To find what per cent. the income is of the investment, when stock is purchased at a given price.

1. What per cent. of my investment shall I secure by purchasing the New York 7 per cents. at 105 %?

OPERATION.

$.07 \div 1.05 = 6\frac{2}{3}$ %.

ANALYSIS. Since $1 of the stock will *cost* $1.05, and *pay* $.07, the income is $\frac{7}{105} = 6\frac{2}{3}$ % of the investment. Hence the

RULE. *Divide the annual rate of income which the stock bears by the price of the stock; the quotient will be the rate upon the investment.*

EXAMPLES FOR PRACTICE.

1. What per cent. of his money will a man obtain by investing in 6 per cent. stock at 108 %? *Ans.* $5\frac{5}{9}$ %.

2. What is the rate of income upon money invested in 6 per cent. bonds, purchased at a discount of 16 %? *Ans.* $7\frac{1}{7}$ %.

3. Panama railroad stock is at a premium of $34\frac{1}{2}$ %, and the charge for brokerage is $1\frac{1}{2}$ %; what will be the rate of income on an investment in these funds if the stock pays a dividend of $8\frac{1}{2}$ % annually? *Ans.* $6\frac{1}{4}$ %.

4. Which is the better investment, to buy 5's at 70 %, or 6's at 80 %?

5. Which is the more profitable, to buy 8's at 120 %, or 5's at 75 %?

6. What is the rate of income upon money invested in U. S. 7–30's at 106 %? *Ans.* $6\frac{47}{53}$ %.

7. Which is the better investment, U. S. 5–20's of '84 at $108\frac{1}{2}$ %, or U. S. 10–40's at 98 %, and how much per cent. per annum? *Ans.* U. S. 5–20's, $\frac{650}{1315}$ %.

8. If a man invest $10000 in U. S. 10–40's at 98 %, and exchanges them at par for U. S. 7–30's at 102 %, what is his rate of income?

9. What per cent of his money will a man gain by investing in Pacific Railroad 6's at 105 %?

CASE IV.

193. To find the price at which stock must be purchased to obtain a given rate upon the investment.

1. At what price must 6 per cent. stocks be purchased in order to obtain 8 % income on the investment?

OPERATION.

$.06 ÷ .08 = $75.

ANALYSIS. Since $.06, the income of $1 of the stock, is 8 % of the sum paid for it, we have, (**449**), $.06 ÷ .08 = $75, the purchase price. Hence,

RULE. *Divide the annual rate of income which the stock bears by the rate required on the investment; the quotient will be the price of the stock.*

EXAMPLES FOR PRACTICE.

1. What must I pay for Government 5 per cents., that my investment may yield 8 % ? *Ans.* $62\frac{1}{2}$ %.

2. At what rate of discount must the Vermont 6 per cent. bonds be purchased that the person investing may secure $6\frac{1}{4}$ % upon his money? *Ans.* 4 %.

3. What rate of premium does 7 per cent. stock bear in the market when an investment pays 6 % ?

4. A speculator invested in a Life Insurance Company, and received a dividend of 6 %, which was $8\frac{1}{3}$ % on his investment; at what price did he purchase? *Ans.* 72 %.

5. What must I pay for U. S. 10–40's, that my investment may yield 6 % ? *Ans.* $83\frac{1}{3}$ %.

6. What rate of premium does U. S. 6's 5-20 bear in market when an investment pays 5 % ?

7. At what rate of discount must U S. 7–30's be purchased, that the investment shall yield 10 % ?

8. What must I pay for government 6's of '81, that my investment may yield 7 % ?

GOLD INVESTMENTS.

493 a. Currency is a term used in commercial language, *First*, To denote the aggregate of Specie and Bills of Exchange, Bank Bills, Treasury Notes, and other substitutes for money employed in buying, selling, and carrying on exchange of commodities between various nations. *Second*, To denote whatever circulating medium is used in any country as a substitute for the government standard. In this latter sense, the paper circulating medium, when below par, is called Currency, to distinguish it from gold and silver. If, from any cause, the paper medium depreciates in value, as it has done in the United States, gold becomes an object of investment, the same as stocks. In commercial language, gold is represented as rising and falling; but gold being the standard of value, it cannot vary. The variation is in the medium of circulation substituted for gold; hence, when gold is said to be at a premium, the currency, or circulating medium, is made the standard, while it is virtually below par.

CASE I.

To change gold into currency.

1. How much currency can be bought for $150 in gold when gold is at 170 %?

OPERATION.

$1.70 × 150 = $255

ANALYSIS. Since a dollar of gold is worth $1.70 in currency, there can be as many times $170 of currency bought as there are dollars of gold. Therefore, $1.70 × 150 = $255 is the amount of currency which can be purchased for $150 in gold.

RULE. *Multiply the value of one dollar of gold in currency by the number of dollars of gold.*

2. What is the value, in current funds, of $250.47 gold, when gold is at $142\frac{3}{4}$ %? *Ans.* $357.546 —.

3. If a person holds $6000 U. S. 10–40's, what would be his annual income in current funds if gold is at 157 %? *Ans.* $471.

4. A merchant purchased a bill of goods for which he was to pay $7000 in currency, or $5500 in gold, at his option. Will he gain or lose by accepting the latter proposition, gold being at $138\frac{1}{2}$ %, and how much in currency? *Ans.* Lose $617.50.

mercial language, *First*,
ills of Exchange, Bank
for money employed in
of commodities between
er circulating medium is
overnment standard. In
lium, when below par, is
and silver. If, from any
ue, as it has done in the
investment, the same as
represented as rising and
lue, it cannot vary. The
bstituted for gold; hence,
e currency, or circulating
irtually below par.

t for $150 in gold when

s. Since a dollar of gold is
in currency, there can be
es $170 of currency bought
1.70 × 150 = $255 is the
for $150 in gold.
lar of gold in currency by

ls, of $250.47 gold, when
Ans. $357.546 —.
40's, what would be his an-
157 %? *Ans.* $471.
ods for which he was to pay
t his option. Will he gain
ion, gold being at 138½ %.
Ans. Lose $617.50.

5. Bought broadcloth @ $3 in gold, and sold the same @ $4 in currency. Did I gain or lose by the transaction, and how much per cent. in currency, gold being at 140 %? *Ans.* Lost $4\frac{10}{21}$ %.

6. A broker invested $3000 of gold in U. S. 6's, which were worth 102 % in currency. What was his annual income from the investment, gold being at 134 %? and what the rate per cent.?
Ans. to first, $236.47. *Ans. to last*, $5\frac{43}{51}$ %.

7. A gentleman invested $10,000, current funds, in U. S. 5–20's of '85, at 104 %. What will be his annual income in currency when gold is at 137 %? *Ans.* 790.38\frac{6}{13}$.

CASE II.

To change currency into gold.

1. How much gold can be purchased for $75 current funds, gold being at 150 %?

OPERATION.

$75 ÷ $1.50 = 50

ANALYSIS. A dollar of gold cost $1.50 in currency, therefore there can be as many dollars of gold purchased for $75 in currency as $1.50 is contained times in $75.

RULE. *Divide the amount in currency by the price of gold.*

2. What is the value in gold of a dollar in currency when gold is at 203 %? *Ans.* $.49$\frac{53}{203}$.

3. Gold being the standard, what is the rate of discount upon current funds when gold is at 134 %, 150 %, 175 %, 180 %, 215 %, and 398 %? *Ans. to first*, $25\frac{29}{67}$ %. *Ans. to last*, $74\frac{174}{195}$ %.

4. What is gold quoted at when a dollar in currency is worth 20 cents in gold, 30 cts., 50 cts., 15 cts., 25 cts., and 72 cts.?

5. How many yards of cotton, at 25 cts. in gold, can be purchased for $250 current funds, when gold is at 175 %?
Ans. $571\frac{3}{7}$ yds.

6. Sold $7800 7.30 Treasury Notes, at 105 %, and invested the proceeds in gold at 145 %, with which I bought U. S. 10–40's at 60 % in gold. Will my yearly income be increased or diminished by the transaction, and how much in gold? *Ans.* Increased $78.

7. Which is the better investment, a bond and mortgage at 7 %, or U. S. 10–40's, gold being 134; and what per cent. in gold?